

# **Biaxial Testing of High-Strength Fabric Improves Design of Inflatable Radar Domes**

Large radar installations around the globe continuously watch the skies, unobtrusively providing security to the United States; these systems have been in active use for the past 50 years. Often situated in extreme environments, the radar dishes require shielding from the harsh elements. Air-inflated domes (over 100 ft in diameter) are one structure of choice for providing this essential protection. The radomes are constructed from high-strength fabric that is strong enough to withstand the inflation pressure, high winds, and other environmental loads, yet transparent to the microwave signal to allow precise radar mapping. This fabric is woven from glass fibers for high strength and embedded in a polytetrafluoroethylene resin matrix, akin to the nonstick coatings used on cookware.

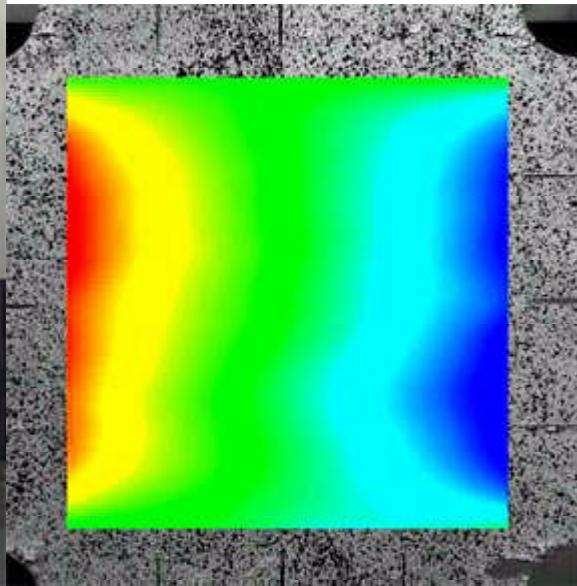
Recently, there have been increasing demands for larger radome installations at locations with more severe wind environments, combined with greater reliability requirements. This has driven a need to better understand the mechanical properties of the material. On the basis of previous fabric testing for the design of aircraft emergency evacuation chutes, Raytheon Company, Electronic Systems Division, contacted the NASA Glenn Research Center's Life Prediction Branch to discuss using Glenn's testing and analysis capabilities. A cost-reimbursable Space Act Agreement was rapidly negotiated to conduct a series of biaxial tests of the glass-Teflon (DuPont) composite material in Glenn's Benchmark Test Facility.

The Chemfab Corporation supplied 36- by 36-in. cruciform fabric specimens in several different new designs, and new load-application fixtures were fabricated for the 100,000-lb-capacity Benchmark Test Facility in-plane load frame to accommodate the specimens. An optical full-field strain measurement system based on speckle-pattern correlation was modified to accommodate the large geometry.

The ongoing testing program will accurately characterize the highly nonlinear, anisotropic, time- and cycle-dependent nature of the fabric. Deformation extensional and rotational moduli and Poisson's ratios along the principal material axes will be determined for over 80 load levels and load ratios. Currently midway through the program, the test results already are proving useful in improved understanding of the material at previously unobtainable high test loads. In addition, the specimen design has evolved to a degree that will allow valid strength testing.



*Air-supported, 160-foot diameter fabric radome installed at Raisting, Germany.*



*Left: Benchmark Test Facility in-plane biaxial load frame with fabric specimen mounted.*

*Right: Fabric specimen under equibiaxial load with full-field strain pattern superimposed.*

The results of this extensive testing program ultimately will allow higher-fidelity design and analysis of inflatable domes, as well as other structures fabricated from the glass-Teflon material. In the end, Glenn's testing will lead to more efficient and greater use, higher durability, longer life, and improved safety and reliability of fabric material designs.

**Find out more about this research:**

**Raytheon Company--Electronic Systems Division (<http://www.raytheon.com/>)**

**Chemfab Corporation ([http://www.fffna.saint-gobain.com/data/aboutus/about\\_us.asp](http://www.fffna.saint-gobain.com/data/aboutus/about_us.asp))**

**NASA Glenn Research Center**

**(<http://www.nasa.gov/centers/glenn/home/index.html>)**

**Glenn's Life Prediction Branch (<http://www.grc.nasa.gov/WWW/LPB/>)**

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